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Whole grain and fiber consumption are associated with lower body weight measures in US adults: National Health and Nutrition Examination Survey 1999-2004

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Abstract

This study examined the association of whole grain consumption with body weight measures and prevalence of overweight/obesity in a recent, nationally representative sample of adults. A secondary analysis of 1999-2004 National Health and Nutrition Examination Survey (NHANES) data was conducted using adults 19 to 50 years of age (y) (n = 7,039) and 51+ y (n = 6,237). Participants were categorized by whole grain consumption: ≥ 0 to <0.6, ≥ 0.6 to <1.5, ≥ 1.5 to <3.0, and ≥ 3.0 servings/day. Main outcome measures included body mass index (BMI), waist circumference (WC), and prevalence of overweight/obesity. Sample weights were applied and the number and percentages of adults in whole grain consumption groups were determined. Least-square means and standard errors were calculated for body weight measures. Two regression models were developed and compared. Model 1 covariates included age, gender, ethnicity, and total energy intake; Model 2 was extended to include cereal fiber. Trend analysis was conducted to test for differences between least-square means. Significance was set at $P \leq .05$. Adults 19-50 and 51+ y consumed a mean of 0.63 and 0.77 servings of whole grains/day, respectively. A significant trend was observed in both age groups for increased consumption of whole grains with lower BMI, WC, and percentage overweight/obese (Model 1); however, a significant trend was not observed when cereal fiber was added as a covariate (Model 2). Results confirm overall whole grain intake well below recommendations, and adults who consumed the most servings of whole grains had lower body weight measures. Results also suggest that fiber in whole grain foods may mediate associations with weight measures in adults. Intake of whole grain foods should be encouraged by health professionals.

Keywords: Whole grains; Fiber; Overweight; Obesity; Adults; NHANES
Abbreviations: BMI, body mass index; WC, waist circumference; NHANES, National Health and Nutrition Examination Survey; US, United States; CVD, cardiovascular disease; CHD, coronary heart disease; FDA, Food and Drug Administration; USDA, US Department of Agriculture; MPED, MyPyramid Equivalents Database; MEC, mobile examination center.

1. Introduction

The majority of grains consumed in the US are refined [1-4], rather than whole. Whole grains include cereal grains that consist of the intact, or ground, cracked or flaked fruit of

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the grains whose principal components are present in the same proportions as they exist in the intact grain [5,6]. Whole grains are nutrient-dense foods composed of protein, lipids, dietary fiber, B vitamins, vitamin E, minerals, and flavonoids and other phytochemicals [7-9]. In the US, wheat comprises 66-67% of whole grains consumed; oats, brown rice, maize, and barley are other commonly consumed whole grains [7]. In 2001-2002, ready-to-eat cereals, corn or tortilla chips, and yeast breads were the major food sources of whole grains (30.9%, 21.7% and 18.1%, respectively) [10].

Studies of intake of whole grains and their potential health benefits [11-15] have been complicated by lack of a standard definition and understanding by consumers of what constitutes a whole grain. Since different studies have used different definitions, it has been difficult to interpret and compare results [16,17]. Jacobs and co-workers [18] recommended a definition of whole grain foods as those with 25% or more whole grains or bran content by weight. Several epidemiologic studies have also used this definition [12,19]; however, the amount of whole grains in each serving can vary considerably and this method did not separate out bran added during processing. Jensen and colleagues [20] calculated whole grain intake by determining the whole grain content of all grain foods according to the dry weight of whole grain ingredients; in that study whole grain intake was calculated with and without bran and germ. The Federal Food and Drug Administration (FDA) allows health claims for whole grain foods that contain ≥ 51% whole grain ingredient(s) by weight per reference amount customarily consumed [21]. The current definition of whole grains in the US excludes bran and pearled barley; most published studies have not used this newer definition. However, there is no internationally accepted definition of whole grains [22]. The USDA's MyPyramid Equivalents Database provides quantified measures of whole grain foods [17,23,34], and this database provides information with and without bran.

Despite these challenges, historically, studies have consistently shown that in industrialized countries, consumption of whole grains has been low in all ethnic and income groups [4]. Data from the Continuing Survey of Food Intake by Individuals (CSFII) was used to show that American adults consumed an average of 6.7 servings of grain products per day; however, only 1.0 serving was from whole grains [1]. In that study, only 8% of individuals consumed at least 3 servings of whole grains per day. More recently, using data from the 1999-2000 National Health and Nutrition Examination Survey (NHANES), it was shown that only 6% of women consumed 3 or more servings of whole grains and that 30% of the final sample consumed no whole grains at all on the day of the recall [24]. Data from 2001-2002 NHANES also showed that less than 10% of grain products consumed were whole grain [10].

Previous epidemiologic and prospective cohort studies of adult populations have reported an inverse relationship between whole grain intake (including bran) and changes in body mass index (BMI), waist circumference (WC), and abdominal adiposity in men and women [24-27]. The objectives of this study were: 1) to examine the relationship of whole grain consumption, using the current definition for whole grain, with body weight measures in a nationally representative sample of adults from the NHANES 1999-2004; and 2) to compare the relationship of whole grain intake with anthropometric measures based on a model with age, gender, ethnicity, and energy as covariates and a model with cereal fiber added as an additional covariate.

2. Methods and materials

2.1. Data collection

The continuous NHANES is a cross-sectional survey that collects data about the nutrition and health status of the US population using a complex, multi-stage, probability sampling design. Data are released in 2 year increments; and as recommended by NHANES, the data sets from 1999-2000, 2001-2002, and 2003-2004 were combined [28] to form a larger sample size. Detailed information about the NHANES design, procedures, and methodologies can be found on the National Center for Health Statistics Web site [29].

Trained interviewers conducted in-person 24-hour dietary recalls using an automated multiple pass data collection method [30,31]. For data collection years, 1999-2002, a single multiple-pass 24-hour dietary recall was conducted during an interview using computer-assisted software to record dietary intake data from participants [32]. In 2003-2004, two days of intake were collected; however, for this study, only the data from the interview administered recall (first recall) were used to assure consistency with the earlier study. Detailed descriptions of the dietary interview methods are provided in the NHANES Dietary Interviewer's Procedure Manual, which includes pictures of the Computer-Assisted Dietary Interview system screens, measurement guides, and charts used to collect dietary information [33].

2.2. Subjects and whole grain consumption categories

The NHANES data collected from 1999-2004 were used in a secondary analysis to compare whole grain consumption and body weight measures in adults 19-50 years of age (y) (n = 7,039) and 51+ y (n = 6,237). These age groups were selected based on the Dietary Reference Intake (DRI) age groupings. Pregnant and lactating females (n = 993) were excluded from the analyses. In addition, there were six foods that were introduced in 2003 that could contain whole grain; however, there was no information in the nutrient database to calculate the whole grain content of these foods. The foods included Milk n' Cereal bar (General Mills, Minneapolis, MN), several character cereals, Berry Burst Cheerios (General Mills), Fruit Harvest cereal (Kellogg, Battle Creek, MI), and Optimum Nature's Path (Nature Path's Foods, Richmond, BC, Canada). Adults (n = 31) who consumed at least one of these six products were excluded from the sample. Due to the nature of the analysis (secondary data analysis), and the lack of personal identifiers, this study was exempted by the Institutional Review Board of the LSU AgCenter.

Participants were categorized into one of four whole grain consumption groups: ≥ 0 to <0.6 servings, ≥ 0.6 to <1.5 servings, ≥ 1.5 to <3.0 servings, and ≥ 3.0 servings/day (ounce-equivalents). This categorization was chosen because the recommendation for most adults is 3 servings per day; 1.5 servings represents 1/2 of the recommendation; and the average number of servings was approximately 0.6 servings.

2.3. Calculating whole grain and cereal fiber intake

The MyPyramid Equivalents Database (MPED) for USDA Survey Food Codes, versions 1 [17] and 2 [34] were used in NHANES 1999-2002 and 2003-2004, respectively to calculate whole grain intake. The MPED is currently the only database available that provides quantified measures of whole grain foods with separate tables based on the old and new (without bran) definitions for whole grain. MyPyramid equivalents food data files contain the number of servings (or ounce-equivalents) per 100 grams of food by 32 MyPyramid food groups, three of which include whole grain, non-whole grain, and total grain [17,34]. Examples of whole grain food servings contained within the database include one slice of 100% whole grain bread, a cup of 100% whole grain cereal, or 1/2 cup of 100% whole grain hot cereal, cooked pasta, rice, or other grain such as bulgur, oatmeal, and whole cornmeal.

The USDA Community Nutrition Research Group FoodLink staff, in consultation with the Agricultural Research Service's Nutrient Data Laboratory, has classified all grain ingredients used in the Food and Nutrient Database for Dietary Studies (FNDDS) and the CSFII recipe databases as whole grain or non-whole grain. The total number of ounce equivalents of grains/100 grams has been determined for each food. The total number of ounce equivalents was divided into whole grain equivalents and non-whole grain equivalents based on the proportion of the grain ingredients in the food that were whole or non-whole grain. For example, cracked wheat bread contains white wheat flour and bran, which are non-whole grains, and whole wheat flour, which is a whole grain. The white wheat flour and bran contributes 68% to the total weight of the grain ingredients and the whole wheat flour contributes 32%. Thus, of the 4 ounce equivalents/100 grams of cracked wheat bread, 2.7 are non-whole grain and 1.3 are whole grain [34].

Cereal fiber was obtained by totaling all dietary fiber intakes consumed from cereal. This information is obtained from the survey-specific Food and Nutrient Database for Dietary Studies. For each of the three survey cycles, cereal was defined as: 1) drdccmty = 5 (cereal mix/cereal w/adds) for NHANES 1999-2000; 2) drdccmtz = 2 (cereal w/adds) for NHANES 2001-2002; and 3) dr1ccmtx = 2 (cereal w/ additions) for NHANES 2003-2004.

2.4. Anthropometric measures

Physical examinations including measurements of standing height, weight, and WC were obtained by trained staff in Mobile Examination Centers (MEC). The Anthropometry Procedures Manual [35] used in the 1999-2000, 2001-2002, and 2003-2004 NHANES provides information about equipment, calibration methods, quality control, and survey procedures. Body mass index values were calculated as body weight (kilograms) divided by height (meters) squared. Overweight was defined as a BMI value greater than or equal to 25 kg/m^2 and less than 30 kg/m^2 and obesity was defined as a BMI greater than or equal to 30 kg/m^2 [36].

2.5. Statistical analyses

Sample-weighted data were used in all statistical analyses, and all analyses were performed using SUDAAN Release 9.0.1 (Research Triangle Institute, Research Triangle Park, NC) to adjust the variance for the complex sample design. For the 6-years 1999-2004, a 6-year MEC-examined sample weight variable was created by assigning 2/3 of the 4-year MEC-examined sample weight for 1999-2002 if the person was sampled in 1999-2002, or 1/3 of the 2-year MEC-examined sample weight for 2003-2004 if the person was sampled in 2003-2004 [28].

Sample-weighted numbers and percentages of adults in whole grain consumption groups were calculated using PROC CROSSTAB of SUDAAN. Sample-weighted unadjusted mean whole grain intake was calculated using PROC DESCRIPT of SUDAAN. To control for covariates, least-square mean whole grain intake, total cereal fiber, and least-square mean body weight measures, standard errors of the least-square means, and t-test statistics for differences between least-square means were calculated using PROC REGRESS of SUDAAN. *P* for trend analysis was conducted to tests for trends in differences in least-square means.

Analyses were conducted separately for adults 19-50 y and 51+ y. Two regression models were developed and compared. In the first model (Model 1), least-square means were calculated to adjust the between-group differences for age (years), gender, ethnicity, and total energy intake. A second model (Model 2) was extended to include cereal fiber as a covariate. A probability ≤ 0.05 was considered significant.

3. Results

Mean whole grain consumption among adults 19-50 y and 51+ y was 0.63 and 0.77 servings/day, respectively (Table 1). Only 4.9% and 6.6% of individuals in these age groups, respectively, consumed 3 or more whole grain servings. Approximately 72% of adults 19-50 y and 66% of adults 51+ y consumed less than 0.6 servings of whole grains.

Table 1
Unadjusted mean body weight measures in adults 19 to 50 and 51+ years of age: NHANES 1999-2004

Variable	19-50 Years (n = 7039)	51+ Years (n = 6237)
BMI (kg/m^2)	27.78 ± 0.09	28.58 ± 0.10
Waist circumference (cm)	94.14 ± 0.23	100.0 ± 0.24
% Overweight [a]	32.14 ± 0.68	37.93 ± 0.79
% Obese [b]	29.39 ± 0.66	33.38 ± 0.78
% Overweight / Obese [c]	61.53 ± 0.71	71.31 ± 0.74

Data are presented as sample-weighted means ± SE using PROC DESCRIPT of SUDAAN. BMI indicates body mass index. % indicates percentage.

[a] Overweight, BMI between 25 and 29.99 kg/m^2.

[b] Obese, BMI ≥ 30 kg/m^2.

[c] Overweight/obese, BMI ≥ 25 kg/m^2.

Two regression models of body weight measures by whole grain consumption group were calculated and compared among adults 19-50 y (Table 2) and 51+ y (Table 3). A comparison of the Model 1 and Model 2 covariate-adjusted mean whole grain intake, total cereal fiber, BMI, WC, and prevalence of overweight/obesity is shown in Table 2 for adults 19-50 y and in Table 3 for adults 51+ y. In both age groups, adjusted total cereal fiber was directly associated with increasing whole grain consumption (*P* for trend < .0001 for both).

In adults 19-50 y, Model 1 covariate-adjusted mean BMI and WC were inversely associated with whole grain intake (*P* for trend = .04 for both). Model 1 also showed that there was a significant trend for whole grain consumption and the percentage of individuals who were overweight/obese (*P* for trend = .01). No significant trends were observed in any body weight measures when cereal fiber was included as a covariate (Model 2).

In adults 51+ y, Model 1 adjusted BMI (*P* for trend = .03) and WC (*P* for trend = .01) were inversely associated with whole grain intake, and subjects in the highest whole grain consumption group had the lowest prevalence of overweight/obesity (67% compared with 72%; *P* for trend = .03) (Table 3). When cereal fiber was added as a covariate, no significant trends were observed.

4. Discussion

The number of servings of whole grains consumed among adults in this study was very low in both age groups examined. More than 70% of adults failed to consume the mean number of servings. In adults 19-50 y, the percentage consuming 3 or more servings was less than 5%. This intake is slightly lower than previously reported [1,4], but was similar to another recent study [24]. Data collected from NHANES 1999-2000 on adult women found that mean whole grain intake was 0.76 servings per day, 30% of women consumed no servings of whole grain, and only 6% consumed at least 3 servings [24]. This difference is likely the result of the change in the definition of whole grain or the database used.

In this study, there was a statistical trend that higher consumption of whole grains was inversely associated with

Table 2
Covariate-adjusted mean body weight measures by whole grain consumption groups in adults 19-50 years of age: NHANES 1999-2004

Dependent variable model	Total population		Whole grain servings groups													*P* for Trend
			Group A ≥ 0 to < 0.6			Group B ≥ 0.6 to < 1.5			Group C ≥ 1.5 to < 3			Group D ≥ 3			
N (%)	7039		5050 (71.7)			970 (13.8)			678 (9.6)			341 (4.9)			
	LSM	SE	LSM	SE		LSM	SE		LSM	SE		LSM	SE		
Whole grain intake (Servings)															
Model 1 [a]	0.71	0.01	0.09	0.00	B C D	1.01	0.01	A C D	2.12	0.02	A B D	4.65	0.11	A B C	—
Model 2 [b]	0.71	0.01	0.11	0.01	B C D	1.00	0.01	A C D	2.05	0.03	A B D	4.51	0.11	A B C	—
Cereal fiber (g)															
Model 1	15.67	0.12	13.85	0.13	B C D	16.89	0.30	A C D	20.33	0.51	A B D	25.11	0.69	A B C	<.0001
Model 2	15.67	0.11	14.28	0.13	B C D	16.60	0.29	A C D	19.25	0.52	A B D	22.92	0.64	A B C	<.0001
BMI (kg/m^2)															
Model 1	27.78	0.09	27.98	0.11	BCD	27.31	0.23	AC	27.26	0.29	A B	27.72	0.42	A	.04
Model 2	27.78	0.09	27.91	0.12	BC	27.36	0.23	AC	27.44	0.29	A B	28.08	0.43		.52
Waist circumference (cm)															
Model 1	94.14	0.22	94.64	0.27	BCD	92.85	0.56	AC	92.72	0.68	A B	94.21	1.03	A	.04
Model 2	94.14	0.22	94.48	0.28	BC	92.97	0.56	AC	93.14	0.70	A B	95.08	1.05		.53
% Overweight / Obese [c]															
Model 1	61.53	0.69	63.08	0.84	CD	59.10	1.88	C	56.55	2.14	A B	59.00	3.00	A	.01
Model 2	61.53	0.69	62.46	0.86	C	59.54	1.88	C	58.10	2.18	A B	62.15	3.12		.41

Data are presented as sample-weighted least-square means and SE using PROC REGRESS of SUDAAN. LSM indicates least square mean. SE indicates standard error. g indicates grams. BMI indicates body mass index. kg/m^2 indicates body weight in kilograms divided by height in meters squared. cm indicates centimeters. Values in the same row that do not share the same superscript letter are significantly different (analysis of variance, *P* < .05).

[a] Model 1 covariates include energy, gender, ethnicity, age.

[b] Model 2 covariates include energy, gender, ethnicity, age, cereal fiber.

[c] Overweight/obese, BMI ≥ 25 kg/m^2.

Table 3
Covariate-adjusted mean body weight measures by whole grain consumption groups in adults 51+ years of age: NHANES 1999-2004

Dependent variable model	Total population		Whole grain servings groups													P for Trend
			Group A ≥ 0 to < 0.6			Group B ≥ 0.6 to < 1.5			Group C ≥ 1.5 to < 3			Group D ≥ 3				
N (%)	6237		4121 (66.1)			942 (15.1)			761 (12.2)			413 (6.6)				
	LSM	SE	LSM	SE		LSM	SE		LSM	SE		LSM	SE			
Whole grain intake (servings)																
Model 1 [a]	0.84	0.01	0.11	0.00	B C D	1.00	0.01	A C D	2.07	0.02	A B D	4.62	0.10	A B C		—
Model 2 [b]	0.84	0.01	0.13	0.01	B C D	0.99	0.01	A C D	2.04	0.03	A B D	4.55	0.11	A B C		—
Cereal fiber (g)																
Model 1	15.73	0.12	13.31	0.15	B C D	17.07	0.28	A C D	19.90	0.38	A B D	26.22	0.75	A B C		<.0001
Model 2	15.73	0.12	14.13	0.16	B C D	16.62	0.27	A C D	18.30	0.38	A B D	22.96	0.78	A B C		<.0001
BMI (kg/m^2)																
Model 1	28.58	0.10	28.74	0.12	C	28.45	0.23	C	28.40	0.28^{AB}	A B	27.90	0.37			.03
Model 2	28.58	0.10	28.64	0.13	C	28.50	0.23	C	28.58	0.30^{AB}	A B	28.28	0.42			.48
Waist circumference (cm)																
Model 1	100.01	0.23	100.58	0.29	BC	99.15	0.57	AC	99.38	0.65	A B	98.25	0.93			.01
Model 2	100.01	0.23	100.37	0.31	C	99.25	0.57	C	99.77	0.70	A B	99.06	1.01			.29
% Overweight / Obese [c]																
Model 1	71.31	0.74	72.02	0.93	C	70.81	1.83	C	70.85	2.03	A B	67.11	2.97			.03
Model 2	71.31	0.73	71.83	0.97	C	70.91	1.83	C	71.20	2.08	A B	67.86	3.20			.08

Data are presented as sample-weighted least-square means and SE using PROC REGRESS of SUDAAN. LSM indicates least square mean. SE indicates standard error. g indicates grams. BMI indicates body mass index. kg/m^2 indicates body weight in kilograms divided by height in meters squared. cm indicates centimeters. Values in the same row that do not share the same superscript letter are significantly different (analysis of variance, $P < .05$).

[a] Model 1 covariates include energy, gender, ethnicity, age.

[b] Model 2 covariates include energy, gender, ethnicity, age, cereal fiber.

[c] Overweight/obese, BMI ≥ 25 kg/m^2.

BMI, WC, and the prevalence of overweight/obesity. These trends did not persist after adjusting for cereal fiber intake. The majority of cross-sectional [24,25,37-39] and prospective cohort studies [11,26,40,41] have observed similar inverse associations with anthropometric variables for whole grain consumption [25,26,39,42,43] and cereal fiber [25,44,45]; although a few studies have not shown this [12,46].

In the *Baltimore Longitudinal Study of Aging* [25], individuals in the highest quintile of whole grain intake had lower BMI, weight, and WC than subjects in the lowest quintile. Similar associations were observed for cereal fiber and anthropometrics. In the *Nurses' Health Study* [26], women who consumed more whole grains consistently weighed less than did women who consumed less whole grains. In the *Iowa Women's Health Study* [18], whole grain intake was inversely correlated with body weight and fat distribution.

In the *Health Professionals Follow-Up Study* [47], an increase in whole grain intake was inversely associated with long-term weight gain. A dose-response relation was observed; weight gain was reduced by 0.49 kg for every 40 g/d increment in whole grain intake. Independent of whole grains, changes in cereal and fruit fiber inversely predicted weight gain. The same approach was used to assess the effect of whole grain, bran, and germ intake on the risk of CHD in men [11]. Added bran and germ were assessed separately and added germ was not associated with CHD risk, suggesting that the fiber-rich bran component was a key factor. In the *Framingham Offspring Study* [43], diets rich in whole grains were inversely associated with BMI and with the waist-to-hip ratio. Weight was 1 to 2 kg higher among those with the lowest intake of whole grain than among those in the upper 20% of whole grain intake.

Fiber was identified as a shortfall nutrient by the 2010 Dietary Guidelines Advisory Committee [48]. Fiber is naturally found in whole grains [7,16]. Fiber intake is associated with improved weight status, serum cholesterol levels, blood pressure, blood sugar control, and laxation [49]. Since whole grains are high in fiber, the relationship of fiber intake to BMI is relevant. In cross-sectional observational studies, fiber has been inversely associated with body weight [50] and body fat [51,52]. In the *Nurses' Health Study* [53], women in the highest quintile of dietary fiber intake had a 49% lower risk of major weight gain. Over 12 years, those with the greatest increase in intake of dietary fiber gained an average of 1.52 kg less than did those with the smallest increase in intake of dietary fiber. In adults the associations between whole grain foods and body weight were partially driven by bran [47], and that the current definition of whole grain foods may not adequately capture all the benefits of reduced body weight associated with whole grain because added bran is excluded from the definition. Although it is difficult to sort out the beneficial effects of whole grains independent of some of their constituents such as fiber and antioxidants, some investigators contend that whole grain consumption is protective beyond what would be predicted if the protection found with the individual compounds were simply additive [54-56].

There is suggestive evidence from a number of secondary analyses that whole grain intake may protect against weight gain and help with weight maintenance although the concept that whole grain intake represents a healthy lifestyle cannot be excluded as a confounder. Compared with low consumers of whole grain foods, high consumers may smoke less, exercise more, and be more likely to use multivitamin supplements [24,43]. Thus, whole grain intake may be just a proxy for a healthy lifestyle. This was not shown by Newby and co-workers [25]; therefore further study is clearly warranted to understand the relationship between weight and consumption of whole grains.

This study had several limitations. NHANES is a cross-sectional study, thus, causal inferences cannot be drawn. Participants relied on their memory to self-report dietary intakes and, therefore, data were subject to non-sampling errors, such as underreporting of energy and examiner effects. It should be noted that use of the multiple pass method reduces bias in energy reporting [30] and there is no evidence that whole grain intake is subject to underreporting. Further, 24-hour dietary recalls may not accurately reflect the usual dietary intake patterns of participants. However, for large sample sizes, such as those available through NHANES, 24-hour recalls produce reasonably accurate group estimates of nutrient intake [57]. The present study did not include physical activity data which may affect weight. It is possible that there could be an inverse association between consumption of whole grains and weight if whole grain consumers exercise more than non-whole grain consumers, since exercise promotes weight loss. Although we demonstrated statistically a linear relationship, more studies are clearly needed to determine if additional associations also occur.

In conclusion, consumption of three or more servings of whole grains in adults was inversely associated with BMI, WC, and the prevalence of overweight/obesity; however, these associations were attenuated by cereal fiber. Data from this study using the current definition of whole grains (excluding bran) were used to examine and compare associations of body weight measures with and without adjustment for cereal fiber. Overall consumption of whole grains was low. Nutrition education programs that increase awareness, health benefits, and consumption of whole grains should be designed. More studies are needed to separate the independent effects of whole grain and fiber on health. Data from this study suggests that cereal fiber is an important component of whole grains and may be more important on body weight measures than whole grain alone.

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